Multipole Ion Guide for Mass Spectrometry

Authors

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Abstract

A multipole ion guide which begins in one pumping stage and extends continuously into one or more subsequent pumping stages has been incorporated into an atmospheric pressure ion source mass spectrometer system. Ions delivered into vacuum from an Electrospray, Atmospheric Pressure Chemical Ionization or Inductively Coupled Plasma ion source are guided and focused into a mass analyzer with high efficiency using the multipole ion guide. The background pressure over a portion of the multipole ion guide length is high enough to cause kinetic energy cooling of ions traversing the ion guide length due to ion collisions with neutral background gas molecules. This ion kinetic energy cooling lowers energy spread of ions traversing the multipole ion guide length. The multipole ion guide DC offset potential can be used to adjust the mean ion energy and the ion guide a_n and q_n values can be set to reduce or expand the range of ion mass to charge which will be transmitted through the ion guide. These features of multipole ion guides and multiple pumping stage multipole ion guides are used to improve performance and lower the cost of Atmospheric Pressure Ion source mass spectrometer instruments.

Field of Invention

This invention relates to the configuration and method of using a multipole ion guide to transport and focus ions which enter vacuum from an atmospheric pressure ion source, into a mass analyzer. The multipole on guide which begins in one vacuum pumping stage has been configured to extend contiguously through one or more subsequent vacuum stages. Multipole ion guides are used to efficiently transfer ions through one or more vacuum stages while allowing the neutral background gas to be pumped away. The AC frequency and AC and DC voltages which are applied to the poles of a multipole ion guide can be set so that the multipole ion guide will pass a selected range of ion mass to charge. The ion transmission properties of multipole ion guides can be used to enhance performance of specific mass analyzer types which are interfaced to atmospheric pressure ion sources.

Background of the Invention

Atmospheric pressure ion sources (API) have become increasingly important as a means for generating ions used in mass analysis. Electrospray or nebulization assisted Electrospray (ES), Atmospheric Pressure Chemical Ionization (APCI) and Inductively Coupled Plasma (ICP) ion sources produce ions from analyte species in a region which is approximately at atmospheric pressure. The ions must then be transported into vacuum for mass analysis. A portion of the ions created in the API source are entrained in the bath gas API source chamber and are swept into vacuum along with a the bath or carrier gas through an orifice into vacuum. Mass spectrometers (MS) generally operate in a vacuum maintained at between 10^{-4} to 10^{-10} torr depending on the